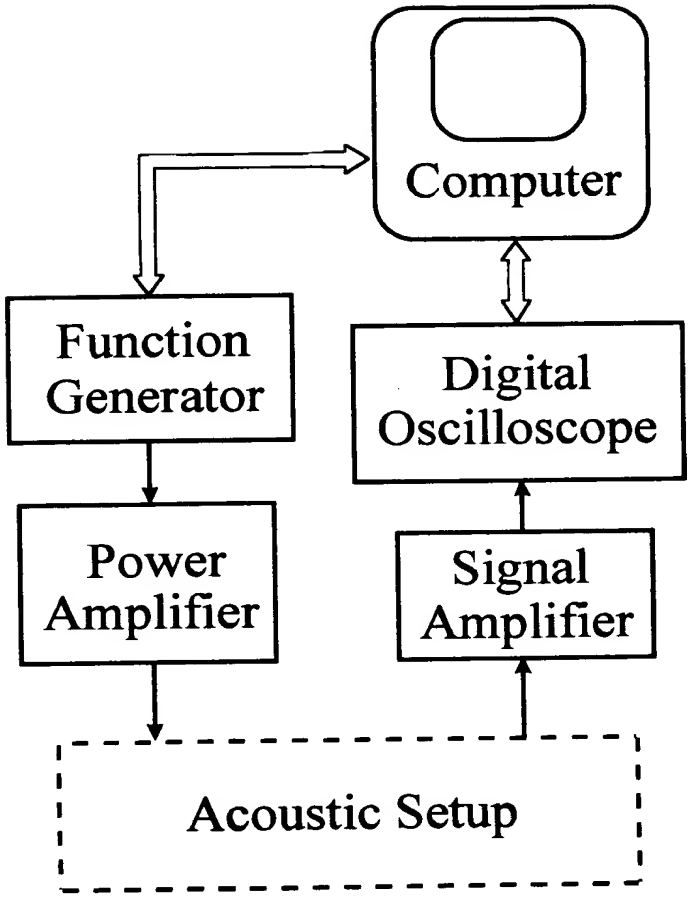


Figure 1. The block diagram of electronic measurement system.

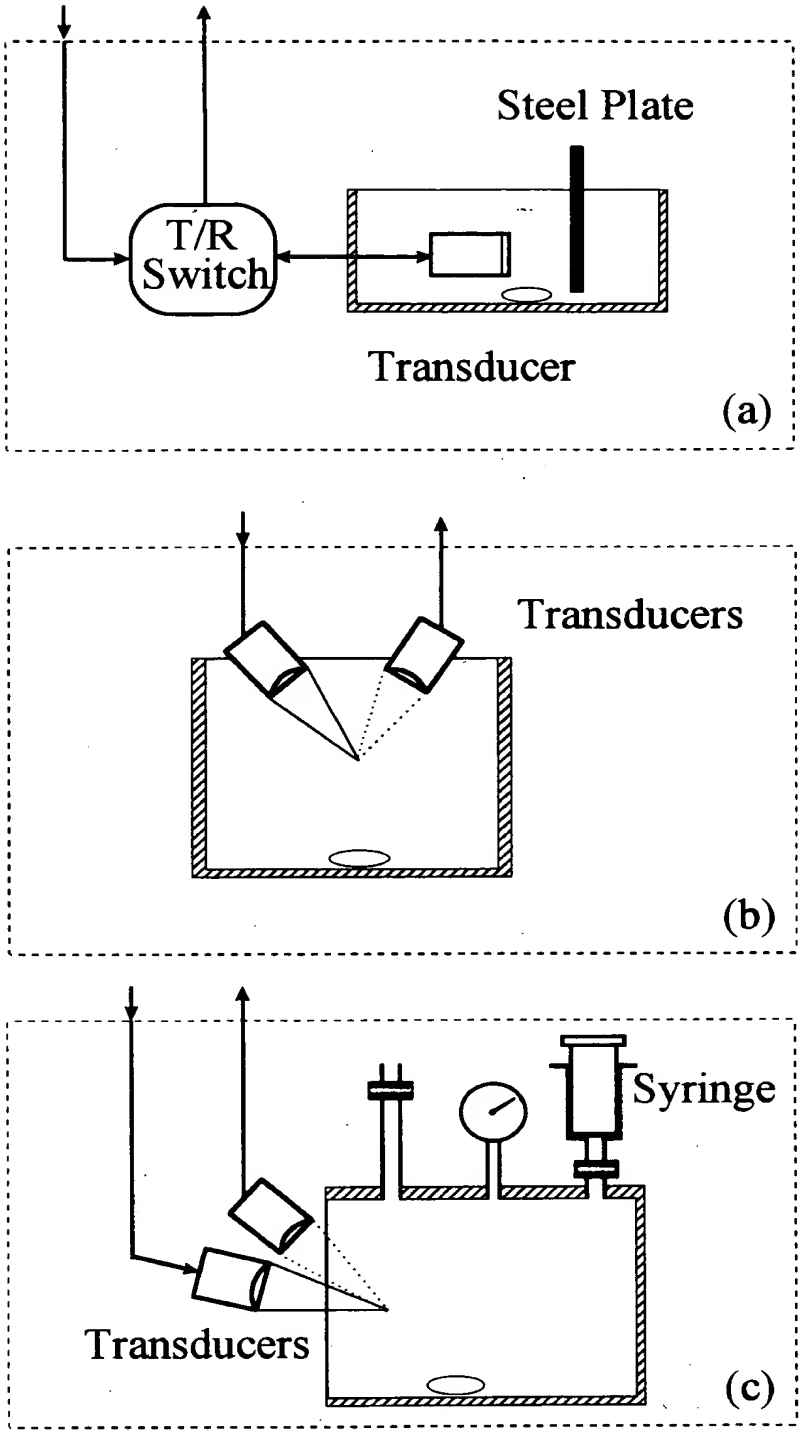
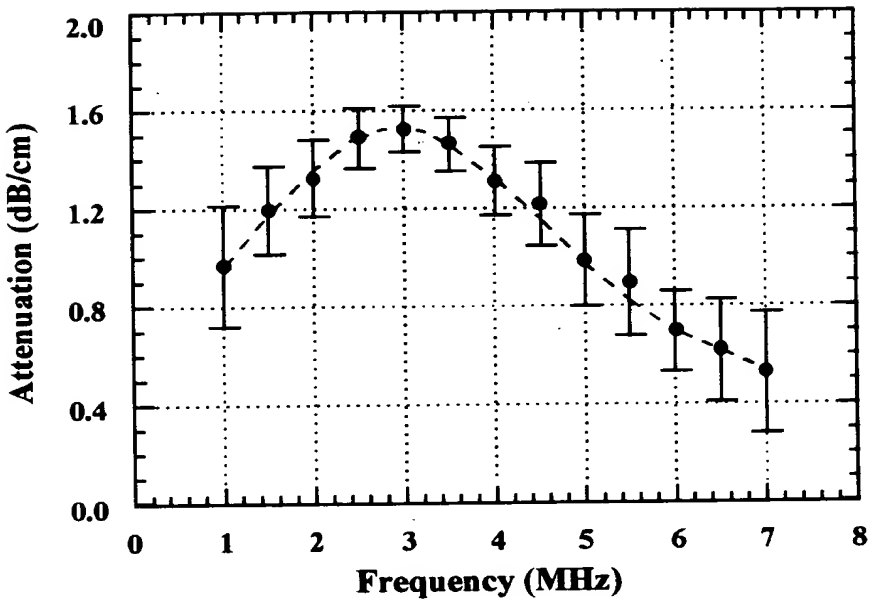


Figure 2. The acoustic setups for (a) the measurement of acoustic attenuation, (b) the subharmonic emission of contrast microbubbles, and (c) the subharmonic response to the change in hydrostatic pressure.



Figures 3. Attenuation as a function of frequency. The experiment was carried out with an injection of 1.5 ml Levovist suspension in into 1.0 liter water. Short acoustic pulses with a duration of 0.16 μs (6.0 MHz, 1 cycle) were sent at a PRF of 5 Hz. The dashed line is a smoothing fit of the experimental data.

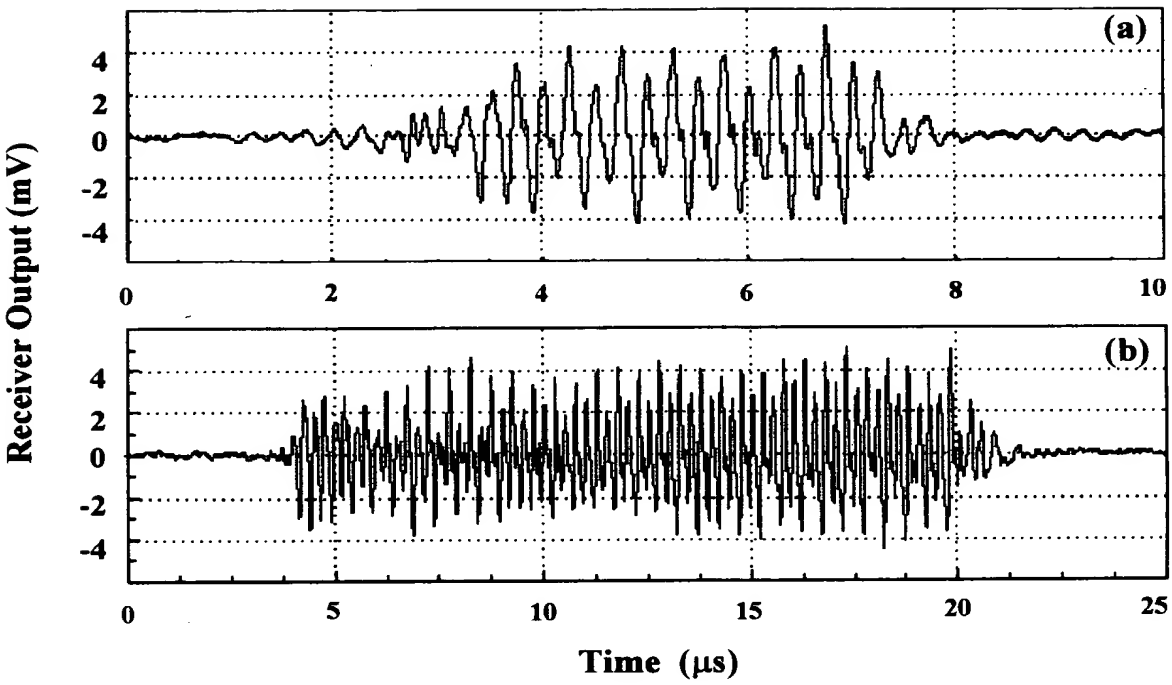


Figure 4a and 4b. Time histories of scattered signals for 16 and 64 cycles transmit ultrasound pulses: (a) time history for 16-cycle transmit pulses and (b) time history for 64-cycle transmit pulses. Acoustic pulses of 0.60 MPa in amplitude were transmitted at a PRF of 5 Hz.

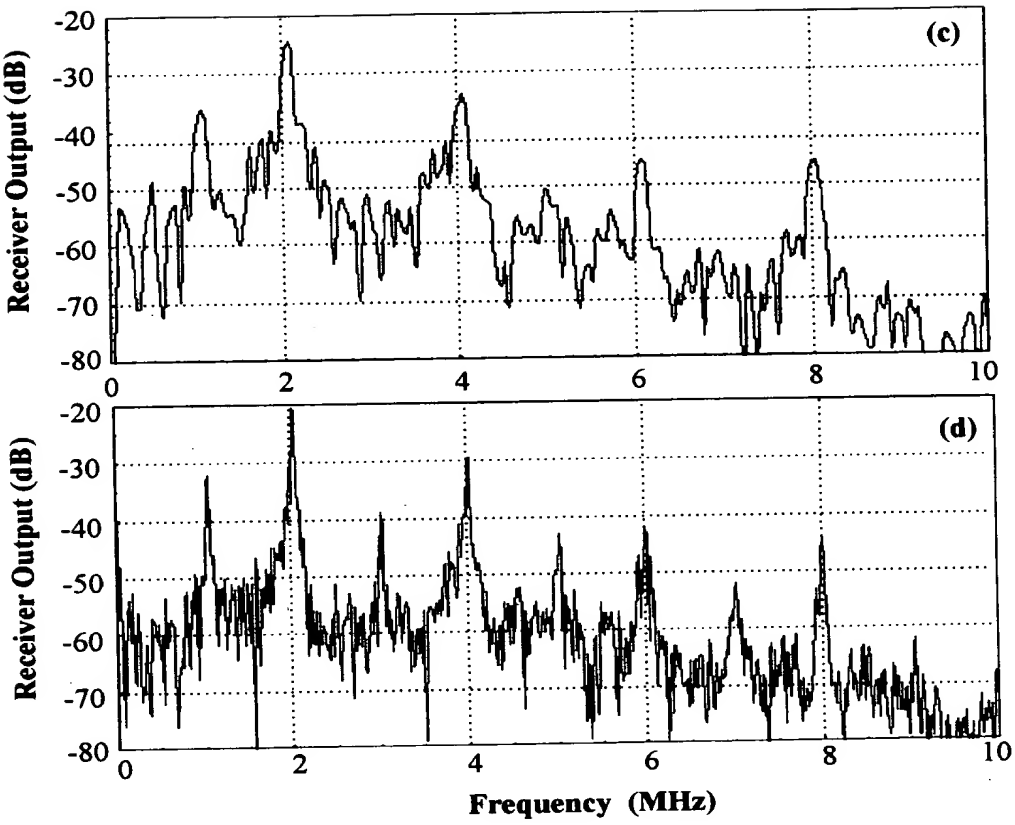


Figure 4c and 4d. Spectra of scattered signals for 16 and 64 cycles transmit ultrasound pulses: (c) spectrum for 16-cycle transmit pulses and (d) spectrum for 64-cycle transmit pulses. Acoustic pulses of 0.60 MPa in amplitude were transmitted at a PRF of 5 Hz.

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0 0 0

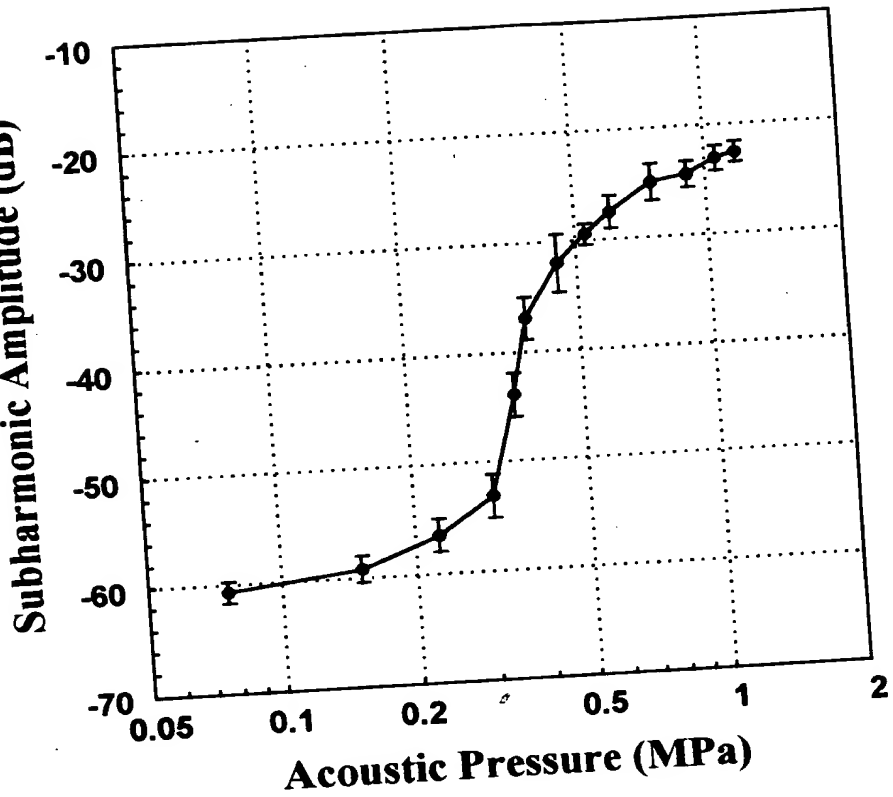


Figure 5. The amplitudes of the subharmonic component as a function of acoustic pressure amplitude. The measurement was performed with an injection of 0.5 ml Levovist suspension into 1.0 liter water. Acoustic pulses with 64 cycles in length were transmitted at a PRF of 5 Hz.

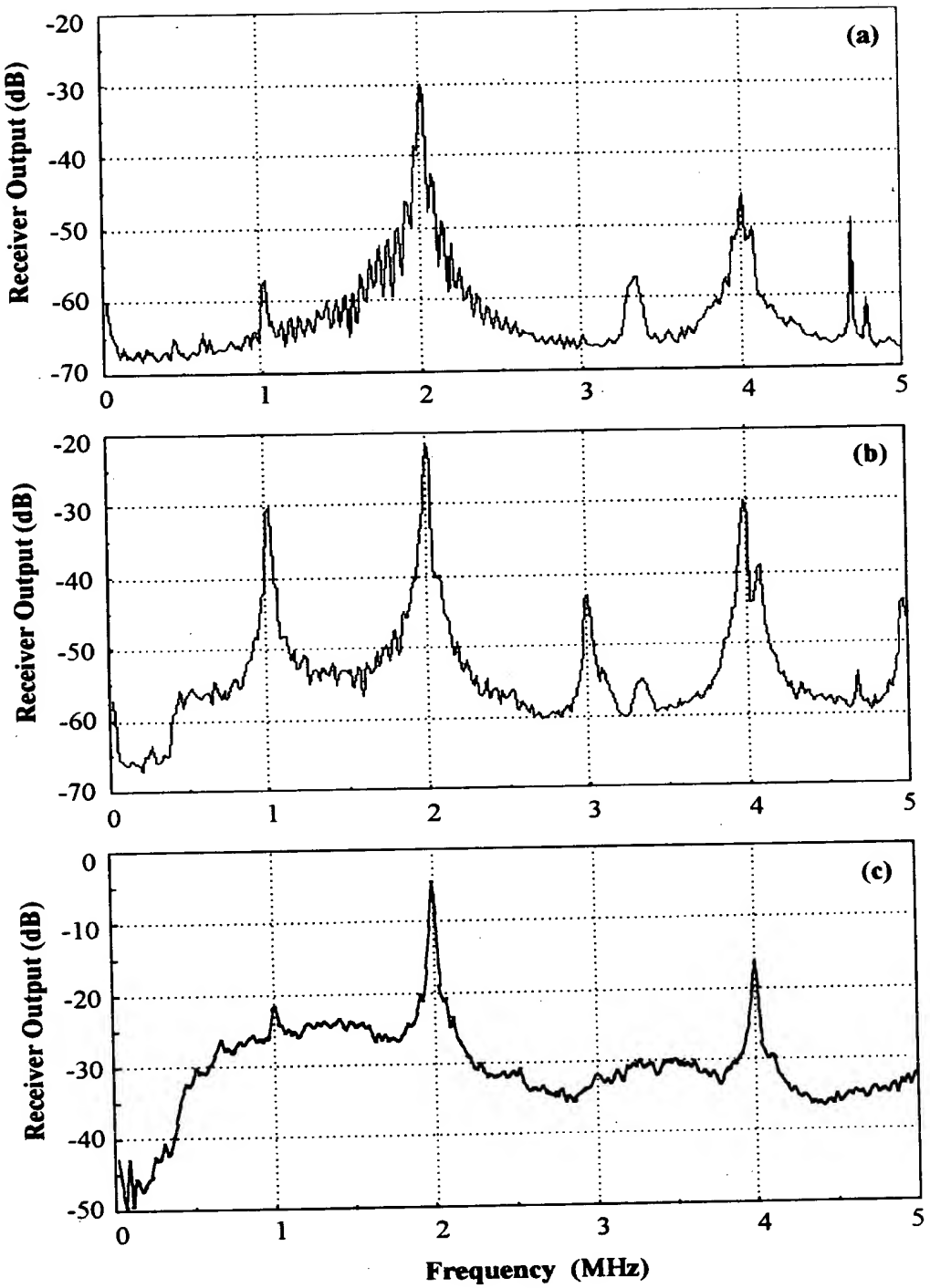


Figure 6 Averaged spectra at different acoustic pressure amplitudes: (a) 0.23 MPa, (b) 0.53 MPa, and (c) 1.17 MPa. The measurement was conducted with an injection of 0.5 ml Levovist suspension into 1.0 liter water. Acoustic pulses with 64 cycles in length were transmitted at a PRF of 5 Hz.

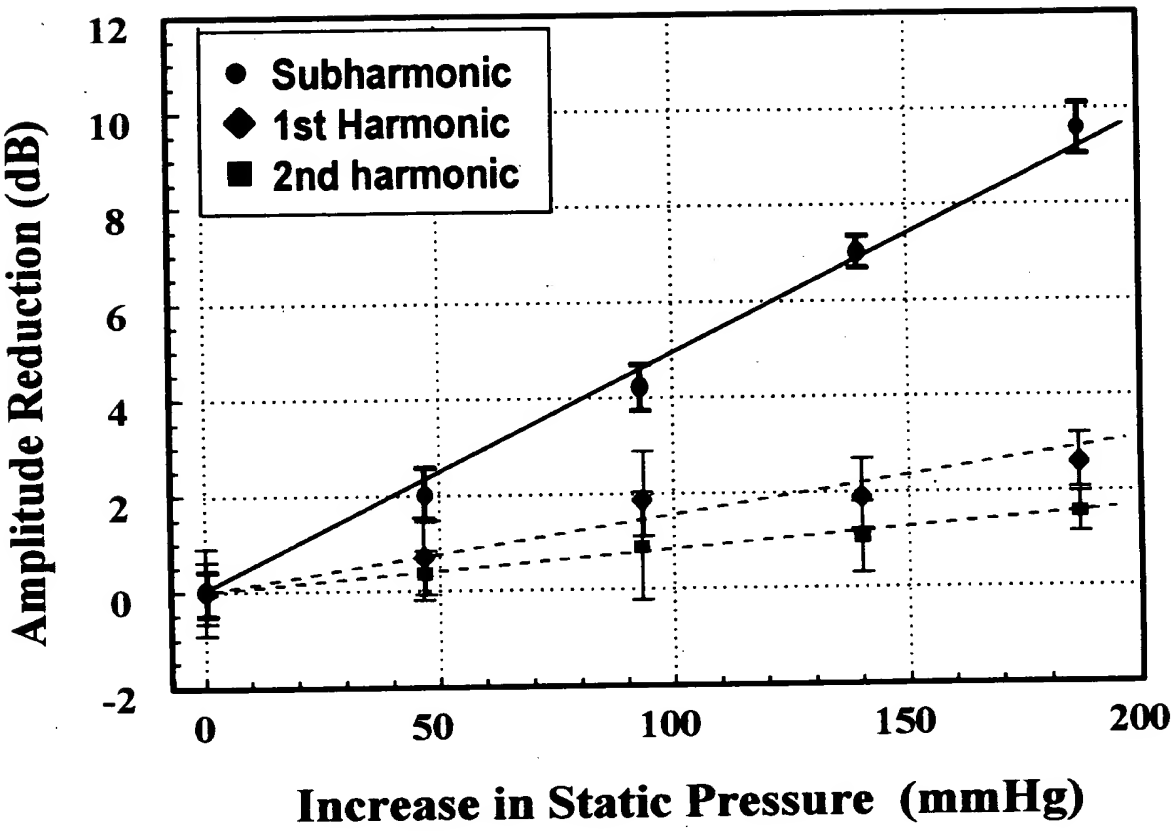


Figure 7. The reductions in the first and second harmonic and subharmonic amplitudes as a function of over-pressure. The measurement was carried out with an injection of 6.0 ml Levovist suspension into 2.25 liter water. Acoustic pulses with 64 cycles in length and 0.39 MPa in amplitude were transmitted at a PRF of 5 Hz.

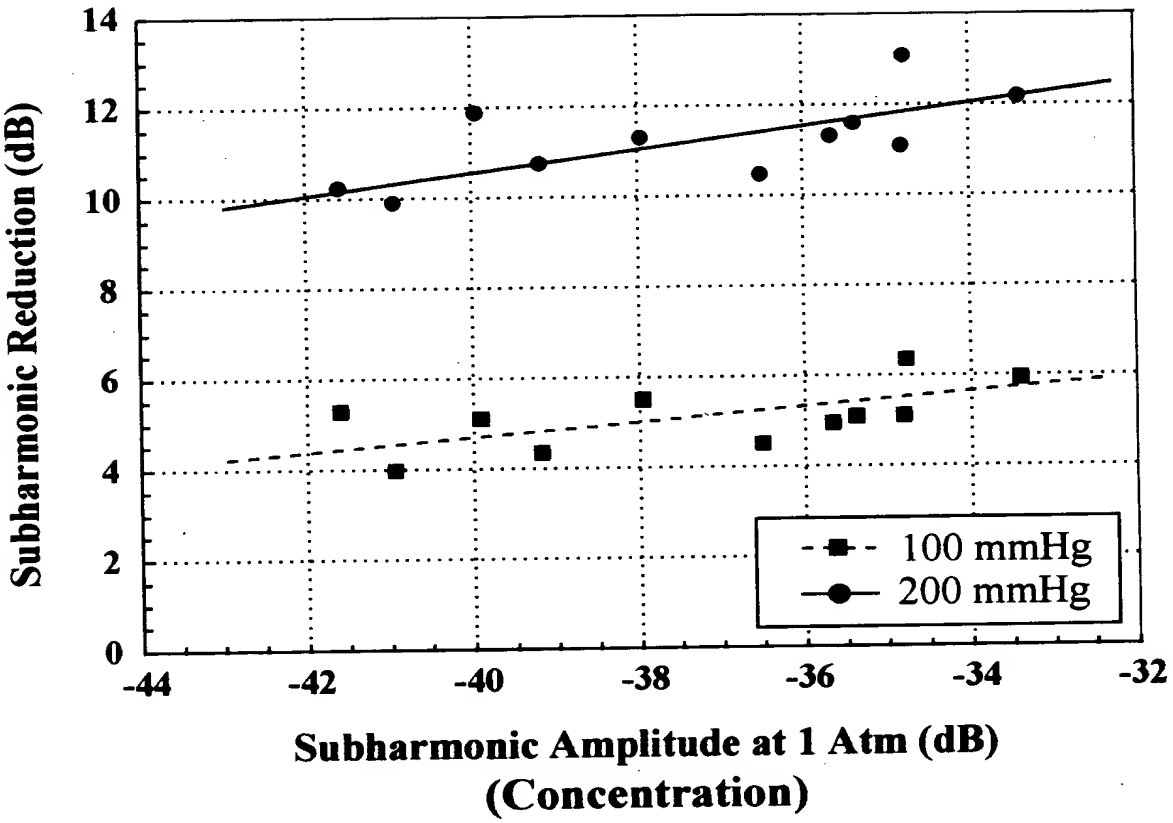


Figure 8. The reduction in the subharmonic amplitudes due to pressure changes of 100 and 200 mm Hg as a function of the received subharmonic signal amplitude at zero over-pressure. Acoustic pulses with 64 cycles in length and 0.39 MPa in amplitude were transmitted at a PRF of 5 Hz. The solid and dashed lines are least square fitting curves.

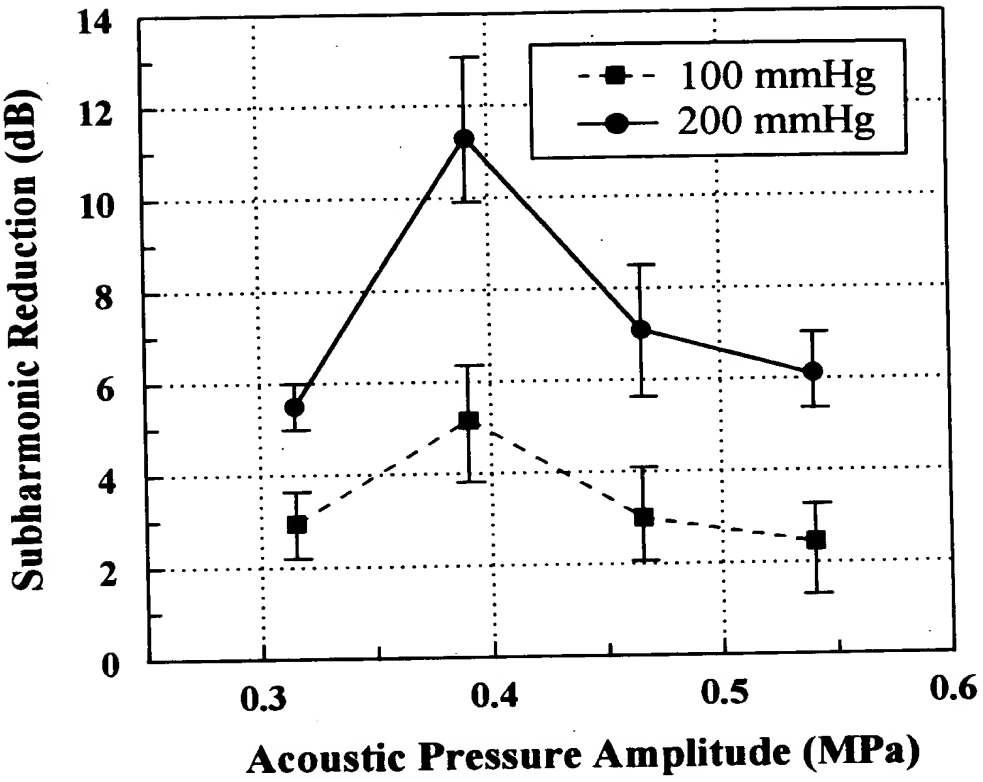


Figure 9. The reduction in the subharmonic amplitude due to pressure changes of 100 and 200 mm Hg at different acoustic pressure amplitudes. The average values (dots) and ranges of experimental data are indicated. During the one-hour long measurement, about 3.0 ml Levovist suspension was injected approximately every 10 minutes after the first injection of 6.0 ml suspension. Acoustic pulses with 64 cycles in length were transmitted at a PRF of 5 Hz.

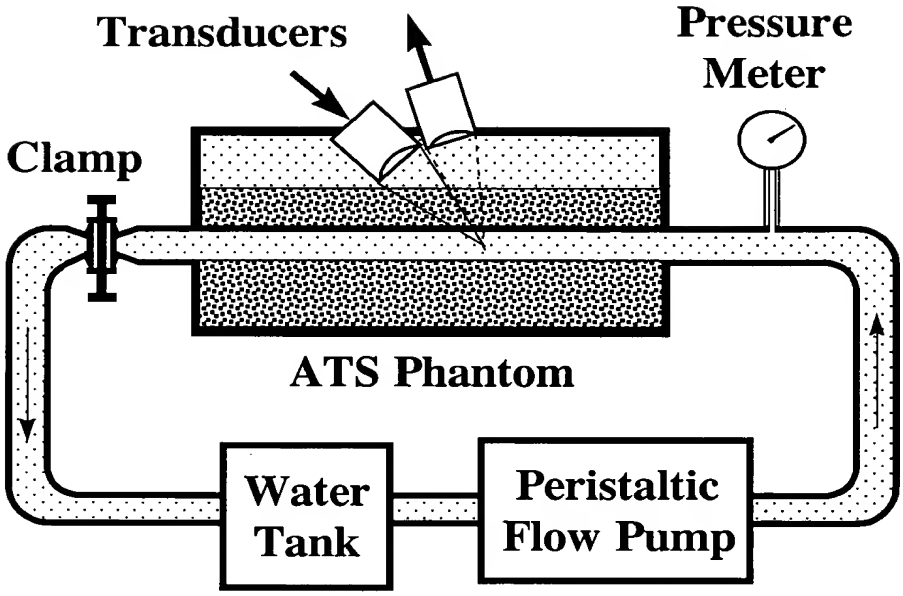


Figure 10. A flow system for the test of SHARP

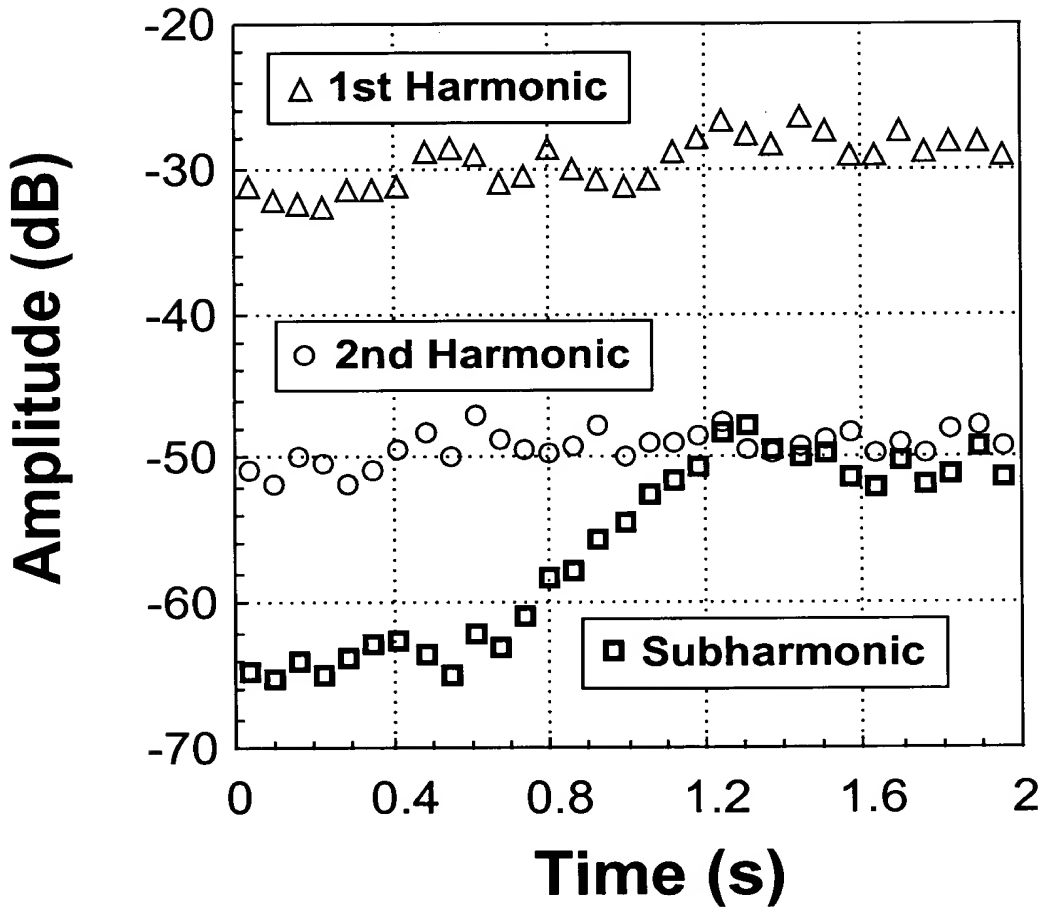
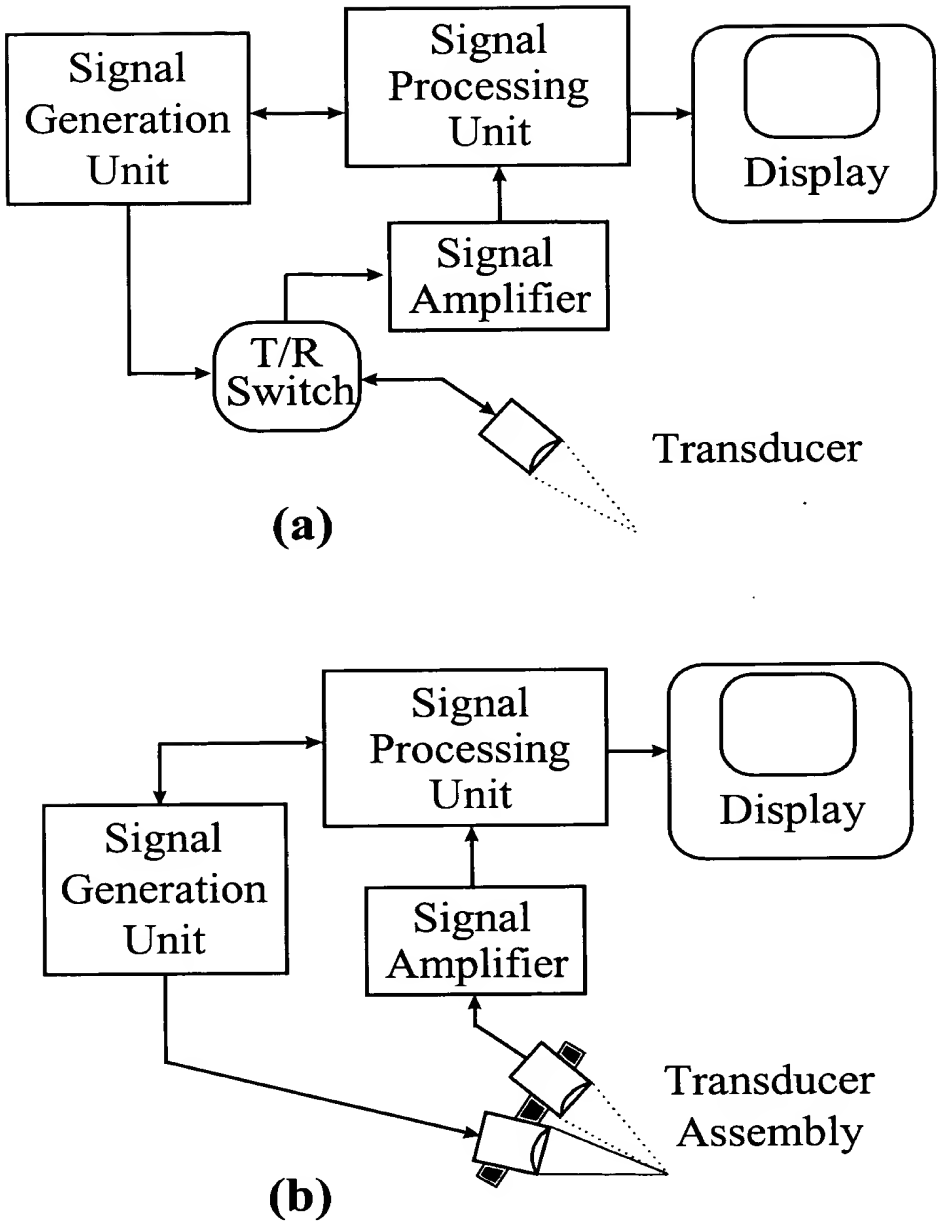


Figure 11. The first and second harmonic and subharmonic amplitudes as a function of time. During the experiment, the hydrostatic pressure inside the vessel decreased as the clapper was released. Ultrasonic pulses with a center frequency of 2.0 MHz and a length of 32 cycles were transmitted at a PRF of 250 Hz.



Figures 12a and 12b. The block diagram of stand-alone single-beam systems with (a) one focused transducer, and (b) two focused transducers.

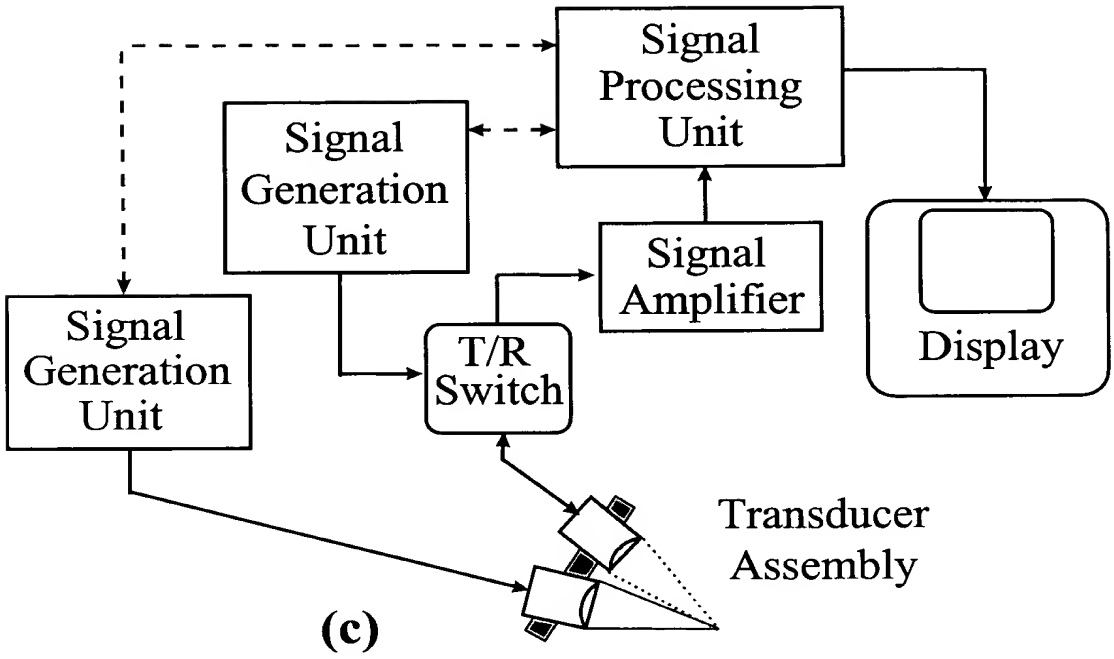


Figure 12c. The block diagram of stand-alone dual-beam systems with two focused transducers.